STUDY PLAN

Fire and Fire Surrogate Treatments in the Southern Coastal Plain
Myakka River State Park, Florida

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I. INTRODUCTION

Native Americans used fire regularly to manipulate and manage the environment around them (see Robbins and Myers 1992, Anderson 1996). Through observation and experience they had learned that regular burning would increase the production of plants they used for food, and for materials for basketry. Fire was also used to clear fields prior to planting, to drive game, and to improve forage that would attract game animals. Removal of the underbrush had added benefits of reducing bothersome insects and providing open areas where enemy advances could be more easily detected. It was the major tool these cultures had for managing their environment.

Early European settlers observed the benefits of burning the landscape and adopted this practice primarily to improve forage for cattle grazing. Woods were burned annually to freshen up the grasses and make them more palatable. This also kept encroachment of shrubby undergrowth in check. Like Native Americans the settlers also used fire to clear fields for agricultural crops. It continued to be the primary tool for manipulation of the environment.

Fire also has the potential for widespread destruction. The extensive logging boom of the late 1800's and early 1900's left vast areas with tremendous fuel levels. Many large wildfires resulted from ignition of these fuels during dry periods. These wildfires caused loss of life and property and left many acres devoid of significant tree cover. Foresters began to advocate removing fire from the woods to protect young trees and allow the forest to re-establish itself. Across the country Federal and State agencies began to build organizations with the equipment and people to improve detection and control of destructive wildfires. This was coupled with educational programs to convince the local woods burners that what they were doing was harmful and wrong.

By the 1950's these efforts had become quite effective at controlling wildfires. However, even the coordinated efforts of a large fire fighting force could not stop wildfires from occurring during significant droughts. Research and practical application began to demonstrate the usefulness of fire to control fuel buildup, thereby reducing the probability of destructive wildfires. This was especially obvious in the South were fuel accumulates rapidly and can reach high levels in 4 to 6 years. It was also recognized that fire had beneficial effects for forestry and the ecosystem when applied under controlled conditions. Thus, we entered an era of application of prescribed fire by trained professionals to obtain desired management objectives (Wade and Lunsford 1988).

The later years of the twentieth century brought a trend of increasingly large and destructive wildfires at various locations across the country. We had become victims of our own success. The modern firefighting detection and control efforts by agencies across the nation had significantly reduced wildfires for a period of time, resulting in the accumulation of heavy fuel loads on more and more acres. Prescribed burning helped to counteract this buildup, but was unable to prevent its occurrence. Controlled burning requires funds, and it is easier to obtain money to fight a wildfire that is an immediate threat than it is to obtain funding for prescribed burning to reduce wildfires in the future. In addition, a growing population and a trend of urban expansion into forested areas, made prescribed burning more difficult and risky.

It became apparent in the 1990's that fuel levels in many systems across the country were at unacceptably high and risky levels. It was also obvious that prescribed burning as currently applied was not alleviating this problem. Recognizing the situation, Congress and the Administration in 1998 established special funding to increase the use of fire and alternative fuel reduction treatments. They also recognized the need for consistent scientific based information about fuels, wildfire risk, fire regimes, and treatment priorities. Lack of information on the long-term effects of fire and altered fire regimes on ecosystem health and air and water quality were also noted. Along with the special funding came a directive to the Department of Interior and the Forest Service to establish a Joint Fire Science Program to supplement existing fire research and answer critical questions using a competitive research grants approach. The Joint Fire Science Board issued a request for proposals to assess fire and fuel treatment effects on ecosystem productivity and health, plant community structure and dynamics, fuel loading and distribution, hydrology and water quality, soil and below ground process, wildlife and fisheries habitat and air quality across all ecosystems. A proposal was submitted after a yearlong development process by a group of researchers from around the country. At the beginning of 2000 the proposal for a National study of the consequences of fire and fire surrogate treatments (FFS) was funded by the Joint Fire Sciences Board for research on 11 sites from the Pacific Northwest to the Southeastern Coastal Plain (Weatherspoon and McIver 2000). This study plan covers research under this proposal at Myakka River State Park, Florida, which is the Southeastern Coastal Plains site.

II. PROBLEM REFERENCE

This work is under the Research Work Unit: Disturbance and the Management of Southern Pine Ecosystems. The study at Myakka River State Park under the Fire, Fire Surrogate National Plan will directly contribute to problem 1.) Sustaining ecosystem productivity and functions requires better understanding of the role of disturbance in southern pine ecosystems and Problem 2.) Improved management practices that more fully emulate desirable influences of natural disturbance regimes are needed to attain productivity and sustainability objectives.

III. LITERATURE

Wildland Fire

The southeast and Florida in particular are centers of lightning activity. Florida has more thunderstorm days per year than anywhere else in the United States (USDA 1941). These lightning strikes have the potential for and do start fires, especially in the early part of the growing season during the normal spring drought (Robbins and Myers 1992). Historically, prior to fragmentation of the landscape, fire was a frequent natural occurrence (every two to eight years) across much of the Southeast (Christensen 1981; Abrahamson & Hartnett 1990; Ware and others 1993). These fires regulated plant composition and favored those species that survived frequent burning. As noted previously, Native American burning historically augmented these natural fires.

This burning kept fuel loads low, thereby reducing the probability of more severe wildfires. Early settlers continued this practice, burning much of area on an annual or biennial basis. The South was one of the first areas where land managers recognized the usefulness and need for frequent prescribed burning to control fuel levels. This resulted in an aggressive prescribed burning program, which was treating around 8 million acres during the 1980's (Wade and Lunsford 1988). Since this time prescribed burning has become more difficult. There has been a large influx of people from other regions of the country where fire was not as prevalent. They do not understand the need for burning and only see the temporary negative aspects of smoke and ash and a blacked area. Increasingly this population growth has occurred on the edge or within forested areas creating a significant amount of wildland to urban interface. This has made prescribed burning much more difficult. Litigation from smoke on highways and an increase in rural highway traffic has also reduced the amount of prescribed burning, especially on private lands.

The Florida wildfires of 1998 demonstrated quite dramatically that there was a serious problem with fuel accumulations in the South. These wildfires consumed half a million acres, destroyed 126 homes and damaged 211 more, destroyed 25 businesses and damaged 8, and damaged or destroyed 86 vehicles. Timber losses from wildfire exceeded 300 million dollars and suppression costs exceeded 130 million dollars. For a period of 2 months these wildfires closed interstates and highways, caused massive evacuations and generally disrupted the life of most residents of Northeast and east central Florida. **Land mangers need and the public is demanding more effective means of controlling fuel buildup and reducing the risk of destructive wildfires.**

Community Composition

Because the ecosystems of the Southeast have developed under and are adapted to frequent low intensity fires, reduction in burning has also resulted in significant changes that are undermining the health and long-term sustainability of many southern communities. Longleaf pine (*Pinus palustris* Mill.) ecosystems for example were once the most prevalent type in the Southeast occupying as much as 23 million hectares, stretching from southeastern Virginia south to central Florida and west into eastern Texas (Stout and Marion 1993). This longleaf pine-grass ecosystem was maintained by frequent fires that inhibited the establishment and growth of competitive but less fire-tolerant species (Clewell 1989). Today longleaf occupies less than 5 percent of its original extent (Outcalt and Sheffield 1996). The continuing reduction of this important forest type threatens a myriad of life forms characteristic of, and largely dependent on, longleaf pine ecosystems. The diversity of ground cover plants per unit area places longleaf pine ecosystems among the most species-rich plant communities outside the Tropics. Extreme habitat reduction is the primary cause for the precarious state of at least 191 taxa of vascular plants (Hardin and White 1989).

Flatwoods, another important community type, with an overstory dominated by longleaf (*Pinus palustris* Mill.) and slash pine (*P. elliottii* Engelm.) covered a large portion of the Southeastern Coastal Plain in pre-Columbian times (Sargent 1884. This vegetation was typical of the broad flat to gently rolling sandy marine deposits (Stout and Marion 1993). Longleaf pine with its associated grassy understory dominated the slightly higher, moderately to poorly drained areas, which burned frequently, i.e. at least every 3 years. Slash pine grew in the wetter areas along the margins of ponds, bays and swamps with mixtures of the two species in the transition zone (Schultz 1983). Only longleaf pine was found in northern and western portions of the Flatwoods, as the natural range of slash pine was restricted to the Coastal Plains from eastern Louisiana to central South Carolina. Longleaf pine however, did not occur south of Lake Okeechobee in Florida and thus flatwoods forest in that area were dominated by slash pine (Little 1971).

Because slash pine is a prolific seed producer it rapidly colonized cut over areas and abandoned fields following European settlement, including many areas formerly dominated by longleaf pine (Schultz 1983). Fire control contributed to the increase in slash pine relative to longleaf as it allowed trees to make it through the fire sensitive seedling stage. Development of the southern pulpwood industry in the 1920’s and 30’s made use of the many young slash pine stands, leading to a new era in forestry. Once it became profitable to harvest and use small southern pine for Kraft pulp there was a shift to more intensive forestry. This often resulted in the replacement of natural stands following harvest with plantations on heavily site prepared areas with a greatly altered understory (Schultz 1976). Due to lack of natural fire and the absence of prescribed burns to duplicate its effects many remaining natural flatwoods habitats have also undergone changes in structure as hardwood trees and shrubs increased in stature.

The south leads the nation in the number of acres prescribed burned yet there are still problems, as outlined above. Burning does reduce fuel loads and thereby the potential of damaging wildfires. However the South is also blessed with a long growing season. In addition, the understory plant community has evolved with and is adapted to fire. Most plants have large below ground structures that allow them to store carbohydrate reserves for rapid sprouting following fire. Thus, fuel buildup following a burn is rapid (Bruce 1951, McNab and others 1978, Sackett 1975) necessitating the need for frequent repeat burns. The required burning is becoming more and more difficult as development encroaches on forested areas and smoke and emission regulations become more stringent. In the absence of frequent burns these stands develop a midstory layer that catches shed needles, accumulates fuel and serves as a ladder to carry ground fires into the tree crowns. There is historical evidence, however, that indicates understories were once much more open and dominated by grasses and forbs with lesser amounts of woody shrubs and palmetto. The more natural grassy systems are much easier to prescribe burn because they ignite more readily and burn faster. Also they burn more completely and produce less residual smoke (DeBano and others 1998). **If we could readjust the composition of the communities then fuel buildup and wildfire problems would be lessened and the health of the ecosystem would be improved.**

Fire Effects Research

There is a wealth of research information on fire in southern ecosystems. Effects on southern pines have been summarized by Wade and Johansen (1986). Growth rates in slash and loblolly pine plantations following prescribed fires decreased as the level of injury increased (Johansen and Wade 1987, Lilieholm and Shih-Chang. 1987). Boyer (1987) found no increase in mortality from repeated fires in longleaf pine stands, although total volume production was reduced. A long-term study in loblolly pine in South Carolina showed frequent, i.e. annual or biennial summer burns, cause significant mortality of woody understory stems (Waldrop and others 1987). The cover of grasses and forbs in the understory was also increased by there frequent summer burns. The effect of fire on soil nutrients was summarized by Wells and others (1979). As noted by Christensen (1987) however, the results vary considerably depending on the methodology used and fire intensity and frequency. The overall conclusion for nitrogen, the critical element most affected because of direct volatilization during combustion, is there are no long-term adverse effects from prescribed burning (McKee 1982). Burning increases the availability of other nutrients by transforming them from organic forms in the vegetation and litter to inorganic forms in the soil (Waldrop and others 1987). The effect of prescribed burning on wildlife includes direct effects such as mortality and nest destruction that vary depending on the season and frequency of burning as it interacts with the autecology of the species of interest. Burning also has indirect effects on wildlife resulting from changes in habitat, which are much more difficult to quantify and are highly variable (see Robbins and Myers 1992). Integrated studies looking at all of the effects of fire discussed above do not exists for the south. **Thus, evaluating benefits and costs from prescribed burning, for all of the different components of the ecosystem is not possible.**

IV. OBJECTIVES

Objectives of this study are to develop treatments that will:

1. Reduce fuel loads and thereby wildfire hazard.
2. Change the stand structure by elimination of the midstory.
3. Readjust the composition and structure of the understory so grasses and forbs are dominant.
4. Accomplish fuel reductions, structural adjustments, and compositional changes without compromising long-term integrity or sustainability of the ecosystem.
5. Be economically and socially acceptable.

V. METHODS

Study Site

The study is located about 25 km southeast of Sarasota, Florida (27^o 10’ N, 82^o 15’ W) (Fig. 1). The locale has a subtropical climate, characterized by high temperatures and humidity, declining only moderately during the winter. Moisture is abundant with most rainfall arriving as convective afternoon thunderstorms during the summer or wet season. The study site is located in the Flatwoods of the eastern Gulf Coastal Plain, with an elevation of less than 15 m above sea level. The terrain is nearly level with slopes typically less than 1%. The soils developed from unconsolidated marine sediments and are dominated by the Myakka series (Aquods). Myakka soils are wet, often poorly drained, sands with an organic-stained subsoil layer occurring at a depth of 60cm. These soils occupy more than 600,000 ha in the Coastal Plain and support flatwoods ecosystems.

The Park in managed by the Division of Recreation and Parks under the Department of Environmental Protection. Both longleaf pine (*Pinus palustris*), which is near the southern limit of its range here, and south Florida slash pine (*Pinus elliottii* var. *densa*) stands occur in the Park with the latter predominating. The flatwoods systems these species occupy are characterized by ascendant saw palmetto (*Serenoa repens*) with a canopy of scattered pines, live oak (*Quercus virginiana*) and sabal palm (*Sabal palmetto*). These pine flatwoods occur throughout the southeastern coastal plain and cover approximately 50 percent of the land area of Florida (Abrahamson and Hartnett 1990). The systems under management by Myakka River State Park are representative of all stages of succession possible within flatwoods. Destructive wildfires can be expected in the Southern Rough or the Palmetto/Gallberry Fuel complex found in flatwoods and Florida dry prairie when normal fire return intervals of 3 to 5 years are exceeded.

The park was once dominated by Florida dry prairie and open, savanna-like pine flatwoods. Flatwoods and prairie systems require frequent fire return intervals (annually to 5 years) to maintain the vegetative aspect and composition which characterizes them; low, herbaceous dominated ground cover with as many as 80 different species per square meter in frequently burned areas having no history of fire interruption. Aggressive fire exclusion and suppression starting in 1934 precipitated advanced succession with heavy fuel build-ups in the highly pyrogenic ground-cover, compositional skewing to woody species (especially saw palmetto), and the advent of far greater densities of pine in those areas of the park successfully " protected" . Highly destructive wildfires evolved as early as 1943 and despite the initiation of a prescribed fire program in the early 1970's, which became very active in the 1980's, the woody dominated understory continues to support atypically intense, often severe fires which preclude pine reestablishment and a return to an herbaceous dominated ground-cover. The conditions on this site exemplify conditions now found throughout Florida.

Treatments

The national study plan calls for four basic treatments utilizing prescribed burning and thinning and their combination along with an untreated control. Our treatments will be slightly different because the fuel problem in the southern coastal plain is in the understory and midstory. They consist of:

1. an untreated control
2. prescribed burning only with periodic reburns as needed
3. mechanical treatment of the understory and midstory with a roller drum chopper
4. prescribed burning followed by mechanical treatment of the understory and midstory with a roller drum chopper with periodic reburns as needed
5. prescribed burning followed by mechanical treatment of the understory and midstory with a large mower with periodic reburns as needed.

Prescribed burns will be conducted during the growing season to mimic the natural fire regime (Table 1). Mechanical treatments will be applied during the dormant season about 6 months after the burn. Follow up burns will be applied 2 to 3 years after the first burn.

Table 1. — Schedule for treatment application at Myakka River State Park site.

Treatment	Block	Timing
Prescribed burn	2	Summer 2000
Mechanical Fuel Reduction	2	January or February 2001
Prescribed Burn	1&3	Summer 2001
Mechanical Fuel Reduction	1&3	January or February 2002
Prescribed Burn	2	Summer 2003
Prescribed Burn	1&3	Summer 2004

Figure 1. Location of Myakka River State Park.

Desired Future Conditions

The overall DFC as defined by the national plan is to create a stand with structure and fuel levels where at least 80 percent of the overstory trees will survive a wildfire that occurs under 80th percentile weather conditions. To achieve this in the saw palmetto / gallberry fuel type requires reduction of the ascendant palmetto from the midstory where it catches shed needles, accumulates fuels, and serves as a ladder to carry ground fires into tree crowns. The desired structure is a two-storied system with overstory trees and an understory of palmetto, shrubs, forbs, and grasses. Additionally, in areas under natural management such as Myakka Park, the understory must be open enough to allow periodic establishment of pine seedlings to replace overstory trees lost to lightning, fire, insects, and disease.

Research following the 1998 Florida wildfires offers some direction on conditions necessary to meet the 80% overstory survival goal (Outcalt and Wade 2000). A large are was burned by wildfire during that season on the Osceola National Forest. The weather conditions were quite severe and were actually in the 90-percentile category. The flatwoods area burned by the wildfire had been regularly prescribed burned on a 3 to 4 year cycle for at least 20 years. Many of the stands did not make the 80% survival criteria. Only the stands on dry sites where the understory was dominated by herbaceous vegetation rather than saw palmetto and woody shrubs, had survival rates within the prescribed range.

Hypothesis

The untreated control is a test of the hypothesis that protection from all disturbances both natural and human is the best alternative. This hands off system was the treatment of choice for a period during the last century when fire control was the main emphasis. It became apparent after a relatively short period of years that wildfires were getting worse as fuel levels rapidly increased. The rapidly escalating wildfire problem resulted in the abandonment of this method and the instigation of regular prescribed burning to control fuel buildup. The non-burned control is valuable and necessary in this study to serve as a basis of comparison for other treatments and to demonstrate to the public the changes and consequences of not controlling fuel buildup in this ecosystem.

The prescribed fire treatment tests the hypothesis that this system evolved under periodic fire and thus it is the most desirable treatment. This is based on the premise that re-introduction of the process of low intensity fires is the only treatment needed to maintain the health of the ecosystem while controlling fuels and wildfire danger. This is the treatment that most managers have been using since the 1960’s. It works quite well and will achieve the desired future conditions of keeping fuels manageable and allowing at least 80 percent of the overstory to survive a wildfire as long as sites are burned every 2 years and it is not a severe drought year. The problem develops because it is extremely difficult to burn all of the sites on such a short return interval. There is the additional restraint that such a short return interval does not allow longleaf seedlings to become large enough to survive the next burn. Thus, regeneration is very rare and the stands continue to lose overstory trees.

The mechanical treatment is designed to test the hypothesis that the system is outside its range of normal variation and requires intervention to restore stand structure. This is based on the principle that restoring structure while reducing fuel loads will lead to restored ecosystem health and a reduced risk of wildfire.

The combination treatments utilizing both mechanical tools and prescribed fire are based on the hypotheses that we must restore both structure and process, which will lead to improved ecosystem health and reduced wildfire hazard. It is also hoped that the combination of treatments in short succession will readjust the composition of the understory. Historically saw palmetto was less abundant in these systems and grasses and forbs were more plentiful. The period of fire protection allowed palmetto to increase in size and abundance at the expense of grasses and forbs. Prescribed burning alone cannot reverse this change because it takes a very intense fire to kill large established saw palmetto or very frequent growing season burns. The intense fires are outside the limits of what is considered safe and thus cannot be used and the frequent burning is a slow process that seldom is accomplished.

The actual null hypothesis to be tested is there are no differences between treatments. Treatments will be compared on the basis of data from a variety of metrics that will directly or indirectly measure changes in vegetation structure and composition and fuel loadings and distribution. Other variables to be tracked are soil nutrient status, wildlife abundance with an emphasis on birds, and insect and disease in overstory pines. Specific hypothesis to be tested at the Myakka River Site are:

1. Treatments will cause changes in stand structure and fuel loads that will reduce overstory mortality from subsequent prescribed fires and encourage natural regeneration.

2. Reduction in the dominance of saw palmetto will cause increases in native plant species diversity and productivity in the understory plant community.

3. Reduction in the dominance of saw palmetto will result in a plant community structure that is less prone to severe fires and less likely to facilitate the spread of surface fires from the forest floor to tree crowns (i.e., lower mortality of overstory and regenerating pines).

4. Modification of the understory and midstory plant community will lead to improvement in the quality of habitat for native wildlife species and thus indicate enhanced sustainability of resource values.

5. Alteration of the dominance relationships among plant species will substantially improve the opportunity for reintroducing frequent low-intensity fires and reduce the risk of high-intensity wildfires that are potentially very destructive in the urban-wildland interface.

6. Fire and mechanical treatments will lead to declining inputs, reduced persistence and decreased onsite accumulation of coarse woody debris.

7. Density and species diversity (richness) of birds is unaffected by different restoration treatments (no treatment, fire, roller-chopping, mowing, and fire and roller-chopping) in Florida pine flatwoods / dry prairie. Alternate hypotheses follow from this null hypothesis, that each treatment may increase or decrease density and diversity.

8. Number of bird young per nest, and survival of young per nest is no different among the different treatments.

9. Bark foraging birds (woodpeckers) do not differ in their response to treated trees.

10. Density and species diversity (richness and heterogeneity) and productivity (number of lactating females) of small mammals is not affected by different treatments.

11. Treatments do not substantially reduce and may actually increase nitrogen turnover rates.

12. Treatments may cause short-term pulses in soil nutrients but these will not be great enough to threaten off site water quality or reduce long-term site productivity.

13. If treatments increase mortality from bark beetles, the increase will not be great enough to preclude the use of that treatment.

14. Additional tree mortality may be beneficial to the birds using the system as feeding and or nesting habitat.

15. The increased stress of treatments will increase tree mortality from root pathogens.

Treatments will also be compared on a cost basis. These comparisons will be guided by the overall objective of finding an economically and socially acceptable system to reduce the hazard of destructive wildfires while maintaining the long-term productivity of the southern coastal plain ecosystem. Because of the number of factors a decision matrix will be constructed to aid in comparing treatments.

Layout and Experimental Design

The basic design is a randomized block with three blocks and 5 treatment units in each. The blocks are different locations that contain a representative sample of the conditions found in these flatwoods systems (Fig. 2). Block 1 is a relatively dry site with an overstory dominated by slash pine with smaller amounts of longleaf pine. Block II is also a relatively dry area but does become wet during the peak of the late summer rainy season. It is dominated by natural longleaf pine. Block III is a relatively wet site that dries out during the dormant dry period but is quite wet with water at or above the soil surface during a good portion of the summer-wet period. South Florida Slash pine dominates the overstory of stands in block III.

Each treatment unit consists of a core area of 12.25 ha and a surrounding 20m buffer giving a total size of 15.2 ha. Within each treatment unit there are 36 grid points on a 50m by 50m spacing. The exact configuration varies for the different treatment units to fit site conditions, but a typical layout consists of a 6 by 6 arrangement (Fig. 3). Grid points were established using a staff compass and tape. A metal post was installed at each grid point and a metal tag was attached designating the grid point number. The first grid point in each line is referenced to marked trees along the treatment unit boundary using direction and distance. A metal marker was installed in the ground at each grid point to facilitate exact relocation following treatment applications. These grid points are the basis for all sampling with information from different response variables tied to the nearest grid point. Grid points are being geo referenced to facilitate tracking.

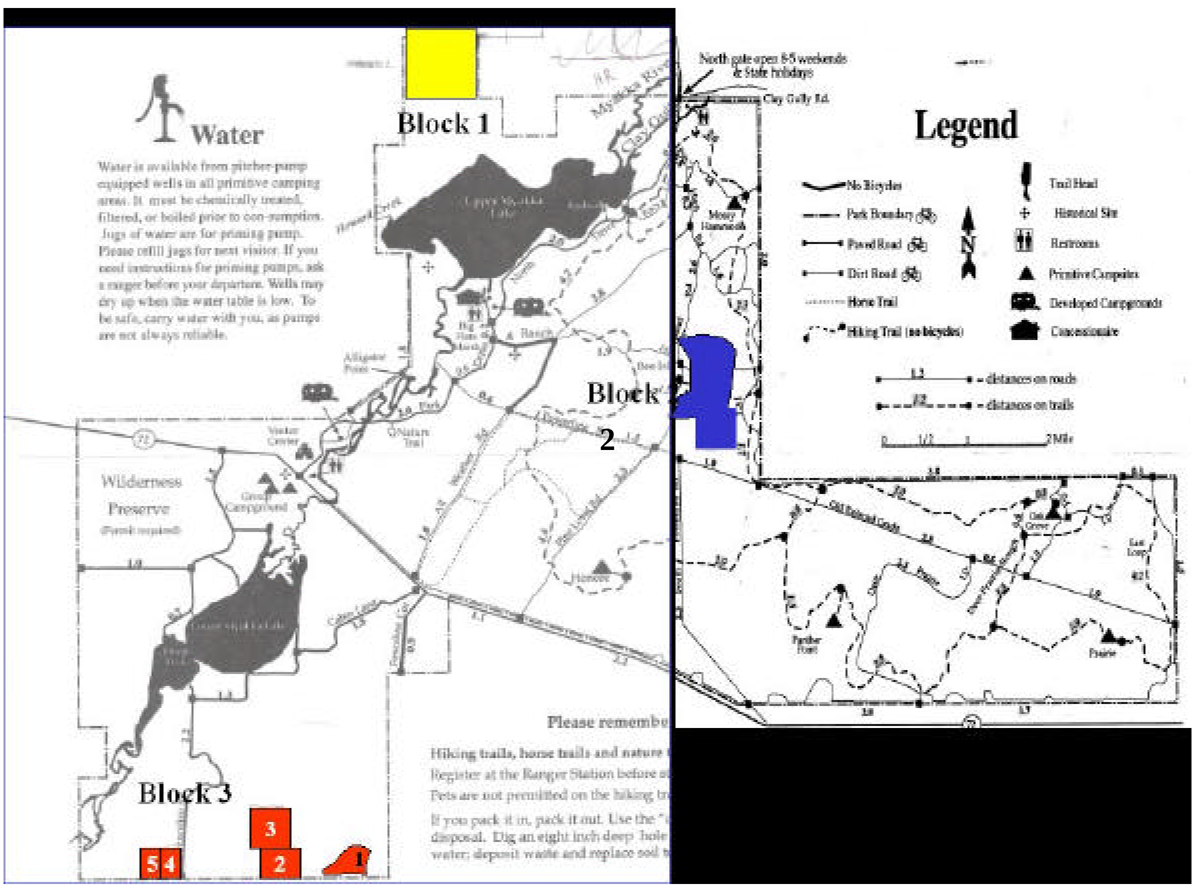

Figure 2.—Location of Fire and Fire Surrogate Study on Myakka River State Park.

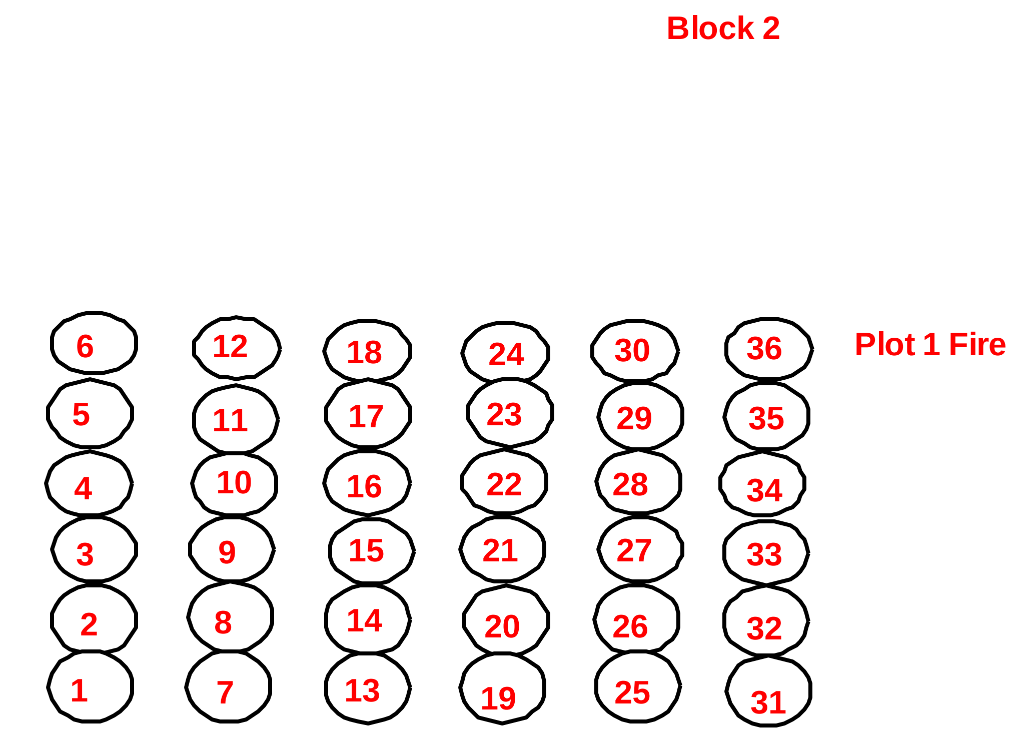

Figure 3. — Treatment unit layout at for fire and fire surrogate study at Myakka River State Park showing the arrangement of grid points.

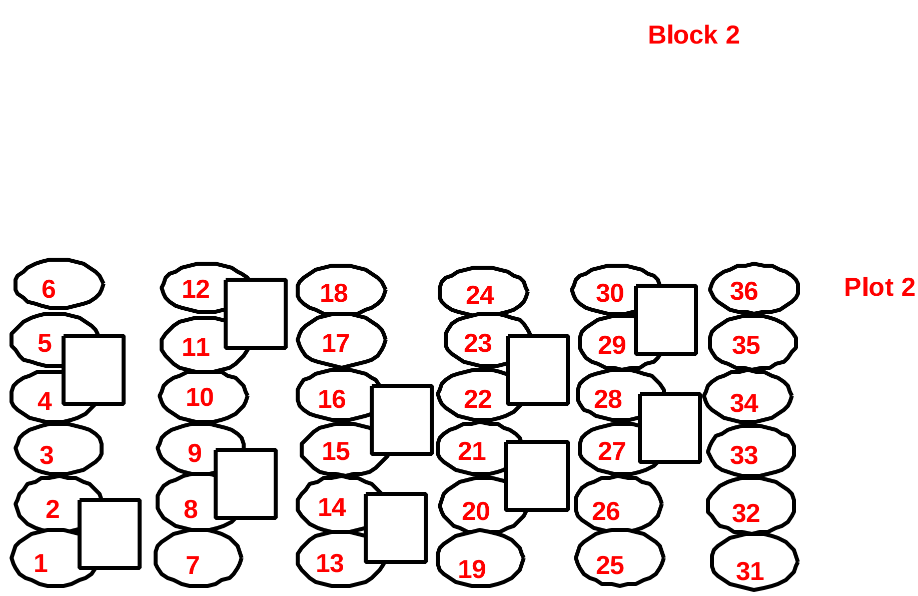

Figure 4. — Arrangement of 20 by 50m sample plots in a typical treatment unit of the fire and fire surrogate study at Myakka River State Park.

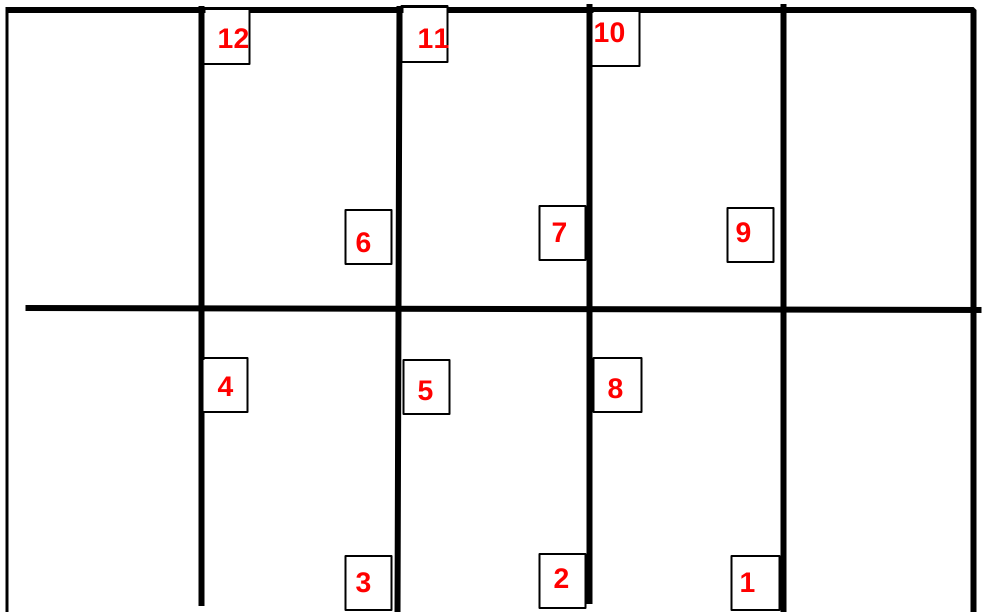

Figure 5. — Location of vegetation subplots (numbered squares) within 20 by 50m sample plots of fire and fire surrogate study at Myakka River State Park.

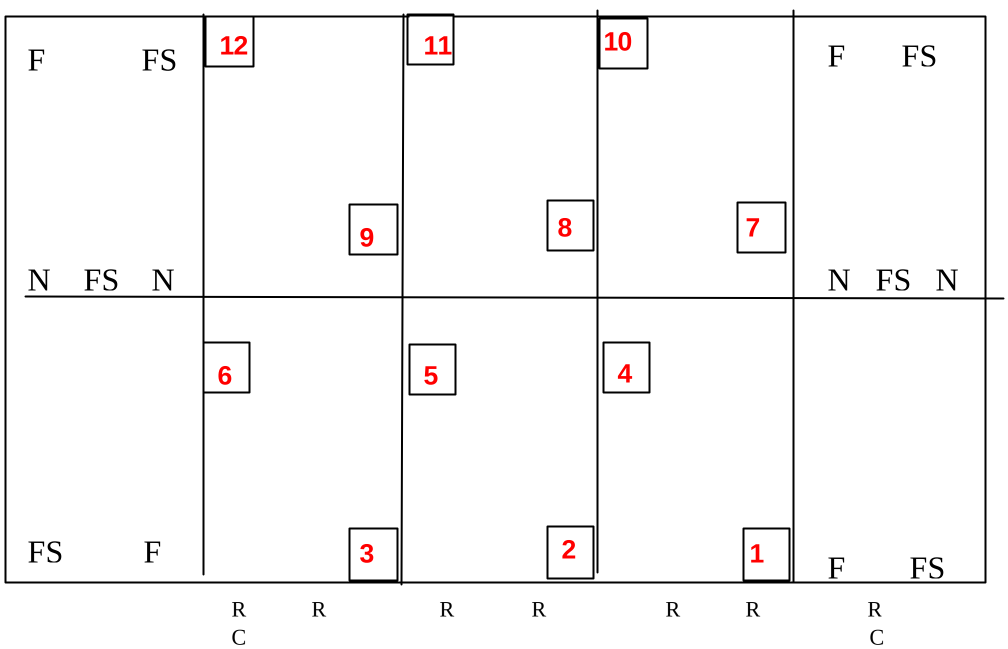

Figure 6. — Location of soils and forest floor sample points in 20 by 50m sample plots of the fire and fire surrogate study at Myakka River State Park. Forest floor and fuels are sampled in 1m square subplots 2m from edge (F). Forest floor and soil nutrient samples are collected from 1m square subplots (FS). Nitrogen turnover samples are collected at 4 locations in each sample plot (N). Bulk density cores are taken along edge of sample plot (C). Penetrometer readings are taken along plot edge (R).

Within each treatment unit there will be ten rectangular 20m by 50m sub-plots established between selected grid points. These sub-plots will be systematically located to sample the range of conditions that exists on the treatment plot. A typical configuration of these sub-plots is shown in Figure 4. The subplots will be used for sampling core variables for vegetation, soils, and fuels utilizing smaller nested sub-sub-plots as appropriate.

Vegetation Protocols

Trees. —The overstory tree layer (all trees > 10cm at dbh) will be sampled on the entire 20 by 50m subplots. Stand structure and composition will be determined by recording the species, diameter, status (live or dead), total height, height to live crown, height to dead crown, and crown condition for each tree on the subplot. Trees will be marked by attaching a metal tag at dbh (1.37m). All trees will be mapped by recording direction and distance from the nearest grid point. Productivity will be determined by changes in diameter from repeated measures taken with a diameter tape. Tree saplings (>1.4m height but <10cm dbh) will also be measured on the entire 20 by 50m subplot. These will be tracked by recording dbh, species, and status. Pine seedlings (< 1.4m but beyond grass stage) will be followed by recording species, height, and status.

Shrub and herbaceous layer. —Structure and composition of the understory vegetation will be tracked by measuring:

1. Foliar cover of each vascular plant species, including forbs, graminoids, vines, shrubs and trees less than 10cm at dbh (saplings and seedlings).

2. Species richness, diversity and evenness of vascular plants.

3. Aboveground biomass of herbaceous plants (graminoids and forbs).

There will be twelve 1m by 1m micro plots in each of the ten subplots in a treatment unit. These micro plots will be systematically located as illustrated in Figure 5. Within each 1 x 1 m micro-plot, the vertically projected foliar cover of each vascular plant species will be visually estimated by classes (<1, 1-10, 11-25, 26-50, 51-75, >75). Cover for tall shrub species (> 1m) will be collected separately from that of ground layer shrubs. At each 1 x 1 m plot, a plant species list will be developed and the % cover for each species estimated. Proper training of field personnel and having the same individuals repeat the measurements during each sampling period will aid in minimizing the errors inherent in this method (lack of consistency in cover estimates). To facilitate comparative analysis of methods for quantifying plant community response to treatment, plant species abundance will also be quantified using the line-intercept method along 15 m transects oriented north and south within each 20 x 50m subplot. These transects will be located 10m from the lower numbered grid point. Readings along these transects should provide an even greater level of precision in measuring plant community dynamics through time. Each transect will be photographed (from a designated photo point) to establish a permanent visual record of plant community status and changes through time. These data will then be transformed into importance values and used to compute various indices of alpha diversity (species richness, diversity, evenness) and construct comparative diversity profiles that display the cumulative proportional abundance in the plant community in response to treatment.

Aboveground herbaceous plant production (standing biomass) will be estimated by clipping all grasses and forbs at the groundline on a $1m^2$ sample plot within each 20 by 50m subplot. Biomass sample plots will be located in relative proximity of transect marker stakes, with actual clipping conducted just beyond the perimeter of the subplot. This procedure will prevent destructive sampling for biomass from adversely affecting plants growing within the subplots. Vegetation samples will be placed into paper bags and weighed before and after drying to constant weight in a force draft oven at 60^oC for no less than 48 hours. All variables will be measured prior to treatment (pretreatment during fall 2000) and then annually thereafter (post-treatment during fall 2001, 2002, 2003, 2004). Plant community composition, cover, structure, diversity and aboveground productivity will be evaluated (Peet and others 1998).

Soils Protocols

All soils data will be collected prior to treatment, 1 year after treatment and again near the end of the study. To determine the C and N content of forest floor a .25 by .25m sample will be collected at 6 locations in each 20 by 50m subplot (Fig. 6) Since our treatment units have been regularly burned, at present there is only a litter layer. It is anticipated that an F and H layer will develop on the control treatments over time. If and when this does happen, the forest floor will be divided by layer. Until this occurs the forest litter will be collected, dried and weighed to determine mass.

Mineral soil will be sampled for C, N, and macronutrient content at the same 6 locations as the forest floor. Mineral soil samples will be stratified by depth into 0 to 10cm and 10 to 20cm layers. Wherever possible, given the underlying variability, samples from a given subplot will be composited prior to chemical analysis. It is hoped that we will be able to composite the 6 samples from a given subplot down to 1-2 samples for chemical analysis without losing precision or accuracy. Analysis of spatial autocorrelation in forest soils from the hardwood site in Ohio indicate that the chemical properties of mineral soil samples are spatially autocorrelated at ranges up to 10m (Boerner and others 1998); thus compositing samples taken within this range does not cause the loss of ecologically-relevant information, at least in the hardwood site.

Pilot analyses of at least 6-12 individual samples from each of at least three sample subplots will be used to establish the degree of acceptable compositing. The criterion to determine the acceptable degree of compositing is a standard error of the mean of the composited samples from a given sample subplot shall not exceed 20% of the magnitude of the mean of those samples. If the standard error does exceed 20% of the magnitude of the mean, too much compositing has been done and more individual samples must be analyzed from each sample subplot.

Subsamples of the composite forest floor samples and mineral soil samples will be analyzed for organic C content by Walkley-Black oxidation/titration (Nelson and Sommers 1982). Subsamples of forest floor will also be digested in H_2SO_4:H_2O_2 and analyzed for total N. Mineral soil samples will be extracted for Ca, Mg, and K with 1M NH_4OAC (Thomas 1982), for Al with 2M KCl, and for P with 0.01M $CaCl_2$ (Olsen and Sommers 1982). Cation analysis will be done by atomic absorption spectroscopy, and P analyses by stannous chloride/molybdate or ascorbic acid colorimetric methods (Olsen and Sommers 1982). Soil pH will be determined in a 1/5 w/v slurry.

Analysis of nutrient availability (i.e. N mineralization and nitrification) will be done for four samples per plot (Fig. 6) during the summer of each year using aerobic, *in situ* incubations for measurement of N mineralization and nitrification. This involves the following steps: (1) taking soil samples from the corners of the plots, (2) separating each sample into two subsamples, (3) placing one of the subsamples into a polyethylene bag and returning it to the hole from which the sample came for a 20-30 day *in situ* incubation, and (4) returning the other subsample to the laboratory for immediate extraction with 2M KCl for subsequent analysis of NH_4 and NO_3 concentration by automated colorimetry (Keeney and Nelson 1982). After 20-30 days, the samples, which have remained in situ in the polyethylene bags, are recovered and extracted for inorganic N the same way. Net N mineralization is calculated as the difference in total inorganic N (NH_4+NO_3) between the initial samples and those incubated *in situ* for 20-30 days. Net nitrification is calculated as the difference between NO_3 in the initial samples and the incubated samples. Proportional nitrification is calculated as the net difference in NO_3 concentration between the initial and incubated samples divided by the total NH_4 available for nitrification (i.e. initial NH_4 + net N mineralization.

Compaction will be measured along transects just outside the boundaries of the subplots. Penetrometer readings will be taken at 5 m intervals from the 10m-point to the 40m-point just outside the plot boundary between the grid points (Fig. 6). This yields 7 measurements per method per plot per year. Bulk density samples will be collected at the 10m and 40m points along the boundary between grid points of the 20 by 50m subplots.

Fuel and Fire Behavior Protocols

Forest floor. —The amount of forest floor material will be determined by collecting a sample from a 1 by 1m area from a location in each 20 by 50m subplot (Fig. 6). Since sites only have an L layer no attempt will be made to develop a depth to weight prediction equation. Collected material will be bagged, dried at 85°C and weighed. An equation does exist based on other factors (McNab and others 1978) and it will be compared to results of clip and bag for possible future use. Duff pins cannot be used to measure removal of the forest floor by fire since most areas do not have a continuous litter layer, but rather contain many areas of bare soil among the litter. Thus, removal will be determined by repeat sampling after prescribed burns.

Surface fuel. —The down dead woody fuels will be measured using the planar intercept method (Brown 1974) and appropriate related techniques (Harmon and others 1986; Bell and others 1996; Harmon & Sexton 1996). Fuel materials will be classified by size class (0-0.25" = 0-6 mm; 0.25-1" = 6-25 mm; 1-3" = 25-75 mm; ≥3" = ≥75 mm), and decay class condition (sound or rotten). The number of intercepts will be recorded for the two smallest size classes over the first 6 feet of each transect, while the number of intercepts for 1 to 3 inch class will be recorded on the first 12 feet. The number of intercepts and diameters of ≥3" diameter material will be recorded by species for the entire transect. The maximum depth of elevated dead woody fuel is also measured over a one-foot (30cm) section at 12 to 13 ft, 25 to 26 ft, and 40 to 41 ft of the transect. Sampling will be performed prior to treatment, after mechanical treatment is completed and after application of the prescribed fire treatments. It is anticipated that at least 4,000 feet (1,220m) of transect will be measured on each treatment unit. Sampling will be performed using two 20m transects randomly placed at each of the 36 grid points. Measurements will be offset by 6 feet (2 meters) from the grid point with the smaller size class fuels being measured at the far end of the transect. These transects will be permanently marked with reinforcement rod. One of the two or more woody fuel transect lines will be randomly selected to serve as the centerline for the course woody debris (CWD) survey strip plot. CWD measurements will be simultaneously performed with the woody fuel measurements to reduce disturbance to the sites.

Sample plots will be established at every other grid point on all experimental treatment units. At each sampled grid point, a strip-plot 20m long and 4m wide will be installed with the respective woody fuel transect line serving as the strip-plot centerline. Within each strip-plot, only logs that are at least 1 m in length and have a large end diameter of ≥15cm will be measured and counted. Small end (>7.62cm) and large end diameters will be measured on all qualifying logs or parts of logs that fall within the boundaries of the strip-plot. If a piece extends outside the strip-plot, diameters will be measured at the point where strip-plot boundary crosses the CWD piece. Piece lengths are the lengths of the CWD that fall within the strip-plot area and will be thus recorded. The length of the entire

CWD piece must be measured to determine its midpoint. If the midpoint falls within the strip-plot, the piece is given an additional rating of "1" for the Indicator Variable. If the midpoint falls outside the strip plot, the piece is given a rating of "0" for the Indicator Variable.

In addition to physical dimensions, the species (if possible) and decay class of each log will be recorded. The following 5 decay classes will be used to rate each CWD piece (Thomas 1979).

1. Decay Class 1: Bark is intact; twigs are present; wood texture is sound; log is still round; original color.

2. Decay Class 2: Bark is intact; twigs are absent; wood texture is sound or becoming soft; log is still round; original wood color.

3. Decay Class 3: Bark is falling off; twigs are absent; wood texture is hard; log is still round; original color of wood is faded.

4. Decay Class 4: Bark is absent; twigs are absent; texture of wood is soft blocky pieces; shape of log is oval; wood has faded to light yellow or gray.

5. Decay Class 5: Bark is absent; twigs are absent; wood texture is soft and powdery; shape of log is oval; wood has faded to light yellow or gray.

Understory fuel. —The grasses, forbs, and shrubs are a very significant component of the total fuel on the Myakka River site. Fortunately a very good equation exists for determining these fuels based on age of rough, height of understory, and coverage of palmetto (McNab and others 1978). This equation will be verified for the site by collecting samples using their procedure from 1m square areas at 4 locations in each 20 by 50m subplot (Fig. 6). In addition to height of understory the average height of palmetto, understory shrubs, and tall shrubs will be taken. The percent cover of forbs, grasses, palmetto, and shrubs will also be estimated. Once verified or adjusted as needed, these equations will be used to determine understory fuel quantities.

Overstory fuel. —This layer will be characterized by using the data collected under the vegetation protocols. In addition crown scorch and bole char will be determined by measurement and ocular estimation after each prescribed burn.

Fuel moisture. —Samples will be collected just prior to each burn treatment. The forest floor will be collected by layers, if they exist. Woody fuel samples will be collected by the standard size classes noted above. Live understory will also be sampled by class (grass, forbs, and shrubs) for fuel moisture. All samples will be placed in moisture proof containers at collection and transported to the lab for determination of green weight. Samples will then be dried to a constant weight at $95^{o}C$ to determine fuel moisture on an oven dry basis.

Fire variables. —Flame length during the burn will be occularly estimated along the flame front. Rate of spread will be determined by timing the passage of the flaming front between points of know distance. These variables will be measured at selected grid points across each treatment unit. Flaming and smoldering stage will also be estimated at the selected grid points. Pertinent weather variables will be recorded on site before, during and after the burn. These include air temperature, relative humidity, wind speed, and wind direction.

Wildlife Protocols

Birds, Point Counts —Two weeks will be spent learning the species, both in the field and using Thayer's® birding software. Point counts will be started in the spring and finished by mid summer. A total of 6 points counts will be conducted per treatment unit. These counts will be done in as random a pattern as possible (given number of staff and vehicles). Counts will be done at grid points, generally 200 meters apart (determined by the shape of the plot). Each count will last 10 minutes. Birds will be recorded as occurring within 10m increments. All 5 treatment plots in each of the 3 blocks will be sampled.

Birds, Nest Productivity —Two plots per treatment were sampled this year. Due to flooding in Block 3 (the southernmost block), we did nest monitoring in Blocks 1 and 2. Four of the five treatments were sampled (mowing treatment was not monitored) for a total of 8 plots. Procedures set forth in the national study plan were followed.

Birds, Functional Response —One crewmember did all the sampling on this section of the project. There are no bark-gleaners in this habitat, so only woodpeckers were sampled. The plots were walked systematically along the grid points, starting the route at a different point each sampling session. Only foraging individuals were sampled, and once the crewmember had sampled one species, he moved on to a different species within that specific plot. After sampling one bird, the spotter used a random number table to obtain the compass direction and distance to another tree of the same category. The data on insect holes and bird activity were recorded.

Small Mammals —Traps were set on the 4 core treatment units (not the mowing treatment) in 2 of the blocks for a total of 8 plots sampled. We used existing grid points (spaced 50m apart) as our sites for traps. As there are no squirrels or large rodents in the dry prairie of Myakka, we used only Sherman XLK traps. Traps were baited with oatmeal. Rodents were bagged, weighed, sexed, checked for lactation, marked (by clipping fur), and released. Traps were checked in the morning, and traps were kept closed during the day, and rebaited in the evening. Trapping was conducted for 10 consecutive days.

Herps —We set pitfall traps (5 Gal. Buckets covered by a lid, and with wet sponges in the bottom) for herps in the 4 core treatment units in Block 2 (Bee

Island site). We caught 3 oak toads and 1 chorus frog in the total of 72 pitfall traps in 10 days of trapping. This sample size was not a large enough to justify the amount of time spent setting pitfalls. Without additional funding to establish drift fencing it seems a waste of time to monitor herps at the Myakka site. However, because of the wet dry season at the site we may have been sampling at the worst time, i.e. at the end of the dry season. Future sampling will be done in the fall near the end of the wet season when populations should be at much higher levels.

Entomology

Before the applications of the treatments the study plots will be censused for bark beetle mortality. At each successive grid point we will scan 180 degrees for trees that are clearly in decline or devoid of needles. As such trees are found, the direction and distance from the grid point will be determined. For each tree, the tree species, bark beetle species responsible for mortality, tree diameter, fading stage (color i.e. lime or light green, straw colored, yellow, red, or gray {old dead}) will be recorded. These data will be collected at each grid point on each study plot. This will allow for bark beetle mortality to be spatially referenced for GIS analysis.

These data will also be collected at 2 and 4 years post-treatment. The variables of interest to be used to detect treatment effects include, but are not limited to, percent mortality/tree species/bark beetle species/year, percent of mortality represented by group kills, mean number of trees per group kill, distribution of morality by diameter class/bark beetle species, incidence (percentage) of bark beetle attacked trees also attacked by secondary insects, percent of tree mortality caused by secondary insects acting alone, and DBH distribution of tree mortality caused by secondary insects.

During phase 1 the entomological data will be collected in accordance with the national plan as stated above. Surveys, however, will be monthly in the summer and bimonthly in the winter owing to the short development times and multiple overlapping generations of the bark beetles. In addition to identifying dates of attack and insect species, notes will be taken on fire injury to the root, stem, and crown, mechanical injuries, and other factors that would dispose the tree to insect infestation.

Pathology

Initial sampling for root disease was begun during summer of 2000. This sampling is part of the pre-treatment survey designed to document stand condition relative to root disease. Block 1 was completed during August 2000. This block contained 5 plots, which were 100% surveyed for symptomatic or dead trees. Trees exhibiting symptoms or recently dead were noted and given a sequential number by nailing a metal tag, starting with # 1, to each individual as they were discovered. Distance and bearing from the nearest grid point were recorded for each symptomatic tree, along with DBH. Distance was measured with a hip chain. Thus, should tags be lost due to fire or to the tree falling, its precise location could still be determined. This is particularly important given past experience with post treatment remeasurements where fire is involved.

Each tagged tree was given a crown class rating based upon foliar symptoms:
0=healthy
1=green, slight thinning
2=mostly green, slight yellowing, shortened internodes
3=pronounced yellow-green color, shortened needles and/or internodes
4=at least 50% crown yellow/yellow brown, 10% green needles
p= dead
Tagged trees were also temporarily flagged with either pink ribbon or green ribbon, for dead individuals or live but symptomatic individuals, respectively.

Insect activity was also recorded for symptomatic trees and categorized as Ambrosia beetles, Southern Pine Beetle, pine sawyer beetle, and/or lightning strike.

From a representative sample of symptomatic trees, root samples were taken by excavation of at least two lateral roots > 5cm diameter from the root collar to about 0.5 m distally. Once exposed, lateral roots were sampled via an increment coring instrument that produced a 4mm diameter 2cm core. Approximately 6 cores were obtained per root and soil was replaced over roots after sampling. A non-symptomatic tree was also tagged and sampled as a control. A small number of putative healthy trees will be sampled in this manner for the remaining plots and blocks as a control. The cores are stored over ice in the field and transported to the laboratory within 7 days. A total of 39 trees were tagged in Block 1. Block III will be sampled in like fashion before the end of the year.

In the laboratory, cores were lightly surface disinfected with a 10% Clorox solution and rinsed in sterile distilled water. Petri plates containing cycloheximide amended 1.25% malt extract broth agar and the same medium minus the cycloheximide was used to isolate root-infecting fungi. The cores were cut into 5mm long pieces and usually four core pieces were placed in each plate. Two plates were used for each sample X medium combination. Plates were incubated at room temperature for 7-10 days and observed daily for growth of fungi. Ophiostomoid complex fungi emerging from samples were hyphal tipped and replated onto fresh amended or non-amended medium for purification. Pure cultures obtained are stored in 5 ml vials containing unamended malt extract medium at 5 C for further identification and study.

Pathogenicity studies on the fungi isolated from these samples are anticipated. Also, studies on carbohydrate metabolizing enzymes in selected trees are planned post-treatment in conjunction with pathogenicity tests. These will be carried out in a manner that minimizes impact on other measurement variables associated with this study.

Economic Protocols

Since there will be no thinning or product removal from our sites this does not require tracking. The cost of treatments however, is important and will be documented. The Myakka River Park staff will be doing the prescribed burning and the mechanical treatments. Prescribed burning is a common practice in the South and average costs for different site conditions are available in published trade journals. This information will be augmented by expert opinion to determine a reasonable cost for this treatment. The chopping treatment that will be applied is commonly used as a site preparation treatment so actual costs are available from bid contracts issued by the National Forests in Florida. Tracking equipment use and personnel, treatment time and total time spent to accomplish the actual treatment will verify these figures.

Data Analyses

Data for dependent variables will be summarized as estimates of the mean for each of the 15 treatment unit plots. Each plot mean will then be used to estimate the mean and variance for each of the treatments. For each dependent variable, a comparison of differences among experimental treatments and through the time sequence of repeated measurements will then be undertaken. Scalar variables will be analyzed by a repeated measures analysis of variance (ANOVA, one-way with Tukey's test), using initial conditions as covariates where appropriate, to evaluate time and treatment effects and interactions (Hintze 1995). Treatment responses will be contrasted using a set of four pairwise comparisons. The trend through time after treatment will be analyzed using orthogonal polynomials. Statistical analysis of the time and treatment interaction for computed vegetation diversity indices will be completed using the bootstrap technique (Efron & Tibshirani 1993; Westfall & Young 1993) PROC TULTTEST in SAS (SAS Institute 1996). Adjusted p-values, which maintain a constant Type I error across the full range of comparisons, will be used to determine significant differences among means (10,000 bootstrap iterations will be used). A probability level of 0.05 will be used to discern significant differences.

VI QUALITY ASSURANCE & QUALITY CONTROL PROCEDURES

Personnel performing data collection functions are responsible for operational maintenance and calibration of all measuring or recording instruments. Accuracy of each instrument will be maintained using the manufacturer's recommended procedures for daily calibration and periodic maintenance. For items such as tree measurements, 20 by 50m subplots will be selected at random for remeasurement to verify data. Persons entering and analyzing data on agency computers are responsible for fully documenting all data entered and for verification of data completeness, accuracy, and precision and for taking corrective action when necessary. After entry data will be printed and compared to original field sheets to insure proper entry of data. For laboratory analyses, such as soils and forest floor, standard practices of inclusion of blanks and samples of known concentration will be run with each batch of samples.

Data will be stored on field data sheets, log books, computer hard drives and backup disks. Numeric data will be stored in spreadsheet form compatible with Microsoft-Excel. File headers will identify fields, units, experimental conditions and other relevant information. All documentation relevant to the study including datasheet hardcopies, backup data disks, and study plans and amendments, will be stored in a fireproof safe at the USDA Forest Service, Southern Research Station, Forestry Sciences Laboratory in Athens, Georgia.

VII APPLICATION OF RESEARCH RESULTS

The common sampling grid will allow the use of both ANOVA and regression to identify linkages among variables at the treatment unit scale. Measuring the extent of fuel reduction and the effect on various processes and components of the ecosystem should help identify ecological thresholds that would be useful for fine-tuning management to achieve more holistic objectives. Collection of both ecological and economic data on numerous sites of common design under similar conditions should allow managers to better assess tradeoffs when prescribing future treatments to achieve management goals.

As one study area in a nationwide network of sites having a similar experimental design, the Coastal Plain site can not only be independently analyzed as an individual site, but can also be used for cross-site comparisons of single and multiple disciplines. Treatment responses of core variables can be analyzed in the following modes:

1. Non-integrated, single discipline at a single site.

2. Integrated, multidisciplinary analyses at a single site.

3. Integrated, single discipline at several sites.

4. Integrated, multidisciplinary analyses at several sites.

Communication among scientists at various sites will be facilitated by the network structure, allowing participating scientists opportunity to gain broader perspectives from other sites as they continue with their site-specific studies in their own region. Those participating in such trans-regional analyses will find their own insights enriched by the greater breadth and depth of data available to them. Managers will also benefit if trans-regional analyses identify common patterns that can be satisfactorily addressed by broad application of management techniques in several ecosystem types. Collaboration between federal researchers and university investigators (faculty and graduate students) will produce a substantial number of high quality publications that will serve the scientific community in refereed journals, land managers in fire management guidebooks and the general public as non-technical advisory literature. There is also the benefit of a well-documented demonstration site where workshops can be staged for both land managers and interested publics. This will allow them to view the effect of the various treatments on fuels, wildfire danger, vegetation, and ecosystem health.

VIII SAFETY & HEALTH

Activities performed during this study require normal procedures such as installation and instrumentation of plots, collection and analysis of data and samples and automobile transportation to and from study sites. No unusually dangerous activities or materials are required. Personnel will follow standard agency safety procedures and exercise due caution when conducting field and laboratory operations. Supervisors will ensure that appropriate Job Hazard Analyses are completed before work begins. Specific precautions will be undertaken for know dangers. The incidence of hantavirus in Florida is very low (one case in the last few years, cf.. CDC website). Contact with rodents will be minimized by holding them with wind at right angles to our bodies and carrying alcohol spray to wash traps and hands. There is very little worry about this virus, as it is mostly spread by dried feces that have been in closed in spaces. Snake leggings or high boots will be used to reduce risk of injury. During electrical storms, everyone will be called out of the field. Safety and health issues for those operating under contract or cooperative agreement are not addressed here.

IX ENVIRONMENTAL ANALYSIS

The Myakka River State Park Manager has filed the necessary environmental assessment documents relevant to this research study, with specific attention to application of the experimental treatments. The State of Florida Department of Environmental Protection approved the plan.

X TIME OF COMPLETION

Timeline

CY2000: Select study sites; install grid points and monuments; install small mammal and herpetofauna traps; obtain aerial photography; collect pretreatment data for vegetation, soils, pathogens, small mammals, herpetofauna, avifauna, entomology, and fuels.

CY2001: Prescribe burn blocks I and III, Mechanical treatment block II, reestablish grid points, monuments, and traps; collect treatment cost data for economics study, collect first-year post-treatment data for vegetation, soils, pathogens, small mammals, herpetofauna, avifauna, entomology, fuels, and social dimensions; analyze data for vegetation, soils, small mammals, herpetofauna, entomology, and fuels.

CY2002: Mechanical treatment blocks I and III, Data collection, analysis and publication for studies of pathogens and avifauna; continued data collection for vegetation; conduct second prescribed burn (if necessary).

CY2003: Data collection for vegetation, collect soil samples; establish follow-up studies for avifauna and entomology; conduct second/third prescribed burn (if necessary).

CY2004: Final data collection, analysis and publication for all studies.

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APPENDIX

Fire at Myakka Study Site

On Thursday July 13 a prescribed burn escaped from the Myakka River Park crew and burned nearly all of block 2 of our FFS installation. The SMIC was informed of the fire and the following three alternatives discussed:

1. Document what happened and continue forward.
2. Re-establish block 2 at another location.
3. Relocate the entire study to another location.

The consensus was to select alternative number 1. It was decided this was the best coarse of action to handle the fire that occurred in block 2. The wildlife data was secured prior to the fire and thus will not be affected. The soils, vegetation, fuels, pathology and bark beetle data will be influenced. Since nearly all of the block burned, and the few grid points in one treatment area that did not are being moved, the entire block is starting from the same condition. All of the blocks at this site had been burned within the last 3 years. The purpose of pretreatment data is to document differences between treatment areas if they exists so variation can be reduced by using a covariate analyses if necessary. We will still have this option for block 2 except the pretreatment data will be from 3 months instead of 3 years after the last burn, as in the other blocks. The one complication the burn did create was a loss of 2 treatments from block 2. Since everything burned we will not have an unburned control or a mechanical only treatment, but rather 2 burn only treatments and 2 burn plus mechanical treatments in this block. Our statistician advised that this type of missing value problem from certain treatments is not something you want, but it does happen quite regularly. The statistical programs can handle it by estimating the missing data based on treatment differences in the other blocks and the overall block mean for block 2. This will reduce slightly our ability to detect differences between treatments because the means test must be reduced by 1 degree of freedom to account for the missing value. Our intention from the beginning was to apply a second burn at year 3 or 4 to all the burn treatments in all blocks. Because of the rapid response rate of vegetation in this system, after the application of the second burn the control and mechanical only treatments of block 2 will again be useable as such.